Duplicate

IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS

ABERYSTWYTH, GREAT BRITAIN

Mimeographed Publication No. 3/1938

CONTENTS

Further investigations on the acceleration of development [vernalization] in wheat varieties. (German.) By J. Voss.

A study of growth in certain grass species, with and without watering. (German). By N. von Bittera and F. von Gruber.

The effect of ascending doses of potassium upon the yield and composition of a clover-grass mixture. (German.) By M. Zehentner.

Alkaloids and nitrogen metabolism in the germination of Lupinus luteus. (Dutch.) By J. C. J. Wallebroek.

The poisoning of cattle by Andropogon sorghum var. Sudanensis. (Second communication.) Intervention of the physiology of the stomachs, with reference to the secretion of saliva. (Spanish.) By J. Riet, L. Echenique and D. L. Sanz.

Translator: Miss G. M. Roseveare.

Issued December, 1938.

Price 2s. 6d.

IMPERIAL BUREAU OF PASTURES & FORAGE CROPS
LIBRARY
ABERYSTWYTH, GREAT BRITAIN

HERBAGE PUBLICATION SERIES

MIMEOGRAPHED PUBLICATIONS

No.

1/1938. Fourth Session of the Academy of Agricultural Sciences, Moscow, U.S.S.R. December, 1936. (Published January, 1938.)

2/1938. Influence of interval between cuts and of height of stubble on yield and root development in grasses, by G. Torstensson. Translated from Swedish by Miss R. Peter Jones. December, 1938.

3/1938. Collection of full or abridged translations by Miss G. M. Roseveare; Vernalization, by J. Voss, from German; Growth in grass species, by N. von Bittera and F. von Gruber, from German; Potassium on a clover-grass mixture, by M. Zehentner, from German; Germination of lupins, by J. C. J. Wallebroek, from Dutch; Poisoning with Sudan grass, by J. Riet and others, from Spanish. December, 1938.

4/1939. Bibliography on red clover (*Trifolium pratense*).

5/1939. Bibliography on white clover (*Trifolium repens*).

6/1939. Bibliography of the published works of V. N. Ljubimenko.

This new series of mimeographed publications will be produced at irregular intervals; it will be experimental in the first instance, until it is known what demand there is for such a service. The different issues will be devoted to the reproduction of full or abridged translations made by the Bureau staff, either for its own purposes or in reply to specific requests; also to bibliographies and other information for which space is not available in *Herbage Reviews*.

There will be no free list for these publications; copies are obtainable at a fixed rate of 2s. 6d. per number. If standing orders are placed for all issues, accounts will be sent at the end of each year, as is the custom with Bulletins. Accounts for individual issues are payable on receipt of publication.

Notice of date of publication of future issues will be sent on request.

IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS,

ABERYSTWYTH, GREAT BRITAIN.

Mimeographed Publication No.3/1938.

A collection of current translations from German, Dutch and Spanish.

Translator : G. M. Roseveare.

Issued December, 1938. Price 2s. 6d.

VOSS, J. Weitere Untersuchungen über Entwicklungsbeschleunigung an Weisensorten, insbesondere an Winterweizen. [Further investigations on the acceleration of development [vernalization] in wheat varieties, especially winter wheat.] Pflanzenbau. 15. 1-35 and 49-79. 1938.

Translation of part of article from German. (G.M.R.)

pp.1-4.

This effect of low temperatures upon the induction of shooting and flowering in winter cereal varieties has been known for a long time. It is only necessary to point to the work of von Seelhorst (46) and Gassner (9), through which incidental observations on the part of practical growers that winter cereals can come to shooting even when sown down in early spring, were experimentally confirmed and explained. Lysenko employed these already known facts on behalf of the farmer by applying the low temperatures only to steeped and scarcely germinating seed, in order, after drying it again, to be able to drill it out. His process can only be considered of practical importance if particular advantages for the farmer are attached to the sowing down of winter cereals treated by his method. Before the method of Lysenko was announced in

German periodicals, a similar process was worked out by me (certainly for quite special purposes of testing varieties) and published in this periodical in March 1934 (54). In order to make rapid determinations of varieties it was found to be necessary to induce earing in winter wheat under constant conditions of warmth in the glasshouse. Based mainly on the work of Gassner (9), this method was worked out. It distinguishes itself from the Russian in that the seeds, receiving a maximal amount of water with a daily eight-hour illumination, germinated slowly at a constant low temperature, on an average mostly at +2° to +3°C. The seedlings at the end of the treatment are generally so far developed that the coleoptile is 2 to 3 cm. long, and frequently the first leaf tip is beginning to emerge (cf. Fig.1) [orig. publ.]. For years extensive variety trials, already running into thousands, have been made by means of this method without a single failure. In every case shooting and earing took place after the described treatment when the plants were grown further in the hothouse (at approximately +20°C. under long-day conditions) in the desired short time (varying according to variety, approximately 8 to 12 weeks, after termination of the treatment).

On the basis of the practical experience already obtained by the Biological Institute [at Berlin-Dahlem] when the Russian methods were made known, in January 1934 (52) it was possible to

point out some important objections which had to be made against the employment of the so-called vernalization process for the growing of cereals in Germany. Through experience obtained meanwhile at several other places on the alleged practical value of vernalization this negative attitude has been completely justified. Reference is made in particular to the publications of Tamm and Preissler (47) and Rosenbaum (36).

If nevertheless further study was made of the question of accelerated development for several years, the reason was not that the methods described were considered of practical use for general agricultural practice. But on the basis of the work already published it had been shown, for the special testing of varieties, that German winter wheat varieties require the already described chilling treatment for varying periods in order to come to shooting and flowering within a short time. Similar findings have now been published in the Russian work also. Gassner's investigations, upon which my employment of the term "cold requirement" in the description of varieties is based, had described the principal aspects of the differing group behaviour of winter and summer forms. An exact determination of the different varietal "cold requirement" within the one group, that of the German winter wheats, was carried out by me in 1933-34, and was taken into consideration in describing the wheat varieties for the purpose of being able to identify them

rapidly.

The further investigations now described, which are a continuation of those described in No.9 of Pflanzenbau, 1934, are concerned with this varietal difference in the cold requirement of winter wheat and its exact determination. Hitherto there has been hardly any detailed experimental investigation on this question, so interesting in many respects. In the second place it was desired, by simultaneous glasshouse trials and experiments in the open, to determine and compare the behaviour of the varieties treated in accordance with the process briefly described above. In the third place it was desired to test the effect of short or long day upon the shooting of winter wheat. Whilst the effect of low temperature especially has been tested again and again in many experiments, there was no exact information in Germany concerning the photoperiodic effect upon shooting in winter wheat, and only isolated data from abroad (cf. Gregory (10), Maximov and Pojarkova (24)). Against this lack of exact experiments there were, however, hypothetical views on the effect of photoperiodism (Wanser, Adams etc.). For this very reason it was desirable, just as formerly the effect of low temperature upon shooting had been tested, to determine now as exactly as possible the effect of short day upon shooting. If it were possible to replace the chilling treatment by use of short day, which generally does not incur the

employment of expensive machinery, it would be possible to simplify the different methods of accelerating the course of development (57, 58). And in addition to these questions, of importance for the testing of varieties, there were also considerations of a theoretical nature which led me to study the effect of length of day upon winter cereals. Brief reference must be made here to the fact that Lysenko, in addition to the far-reaching conclusions for agricultural practice, not applicable to the growing of cereals in Germany, as has been briefly stated, also came to far-reaching conclusions concerning the different phases of development which the plant must traverse in order to come to the flowering stage. On the so-called thermo-stage the second phase, in which the effect of light is of decisive importance, must, it is said, follow (photo-stage). Each of these phases (the existence of still further phases is assumed by the Russians) must be traversed, so it is said, in a definite sequence in order that it may complete its total development up to flowering and ripening.

pp.30-35.

5. Glasshouse experiments in the acceleration of development in winter wheat by the action of short day alone.

It has already been remarked in the introduction that there is little exact information on the effect of length of day

during the first stages of development upon shooting in winter cereals in comparison with the work on the effect of cold. In the German literature the work of Maximov and Pojarkova is referred to, which shows that earing takes place in winter wheat even without the action of cold if it is sown down very early. Later S. Hurwitz (15) and R. Vogt (50) also showed the influence of very early sowing without the action of cold upon earing in winter cereals. In the Russian literature, which is not available to me in the original, the work of E. Lebedinzeva (21) should be mentioned, in which an influence of length of day upon earing in winter cereals was demonstrated. Of English work the detailed investigation of O. Purvis (34) should be mentioned, wherein the influence of short day on a winter rye variety, v. Lochow's Petkus, was demonstrated. As Lysenko had outlined the different phases of development which the plant must traverse in order to come to flowering, it was of interest, in order to test the soundness of his assumptions, doubted also by others than myself, to test the action of short day upon a series of winter wheat varieties. The work was so arranged that it was not the natural short day of winter which was used, as, for example, in the investigations of Hurwitz, Maximov and Pojarkova, but the plants - immediately after the coleoptile had become visible - were exposed to daylight for nine hours and were kept darkened for the rest of the time. The first experiment was laid down on 12.1.1937 with the three

winter wheat varieties Rimpau's Hybrid, Strube's Dickkopf and Criewen 104, at +10°C. One pot per variety and series, each pot containing twenty-five plants, was subjected to the treatment described for four, five, six and seven weeks. At the end of the treatment the pots were placed, together with the non-treated control, in a hothouse under long-day conditions (with supplementary illumination at night) at approximately +20°C. The last series, treated for seven weeks, was brought on 8.3.1937 into the hothouse under long-day conditions. In July complete earing had taken place in all the different treatment series in Strube's Schlanstedt Dickkopf and Rimpau's Hybrid, Criewen 104 exhibited isolated ears, the control no ears at all. The experiment could therefore throw no conclusive light upon the action of short day, because the temperature of approximately +10°C. might also have had an influence upon earing. Certainly in the case of winter wheat a temperature of ±0 to +5°C. is generally regarded as productive of shooting. A new experiment was laid down with the following varieties:

Variety.	Induction of shooting.
Criewen 104	difficult
Salzmünd Standard	medium difficult
Janetzki's Early Cross. L.	easy
Svalöf Kronen	difficult
Strube's General v. Stocken	medium difficult
Rimpau's Hybrid	easy
Carsten V	difficult
Strube's Dickkopf	medium difficult
Ackermann's Bayernkönig	easy

Of each variety five pots received twenty-five seeds on 18.3.1937 and were germinated in the hothouse at approximately +20°C. After the coleoptile became visible the control plants were put in the greenhouse at +20°C. under long-day conditions. The other pots were left at a temperature of +20°C. and (with the exception of Sundays) were exposed daily to daylight for eight and a half hours, and kept dark for the rest of the time.

For watering and nutrient solution see p.59.

The different series were placed in the hothouse under long-day conditions as follows:

The first	after	three	weeks	short-day	treatment)		
" second	"	four	"	"	"	"	} constant
" third	"	five	"	"	"	"	} at 20°C.
" fourth	"	six	"	"	"	"	}

Three further series were germinated in thermostats at an average temperature of +9.7°C. and during the darkening period kept at the same average temperature, during the eight and a half hours daylight action they were put in a temperature of +20°C. (as a room at +10°C. with daylight was not available). Of these series there were placed in the hothouse under long-day conditions the following:

The fifth	after	three and a half	weeks	short-day	treatment)	at	
" sixth	"	four and a half	"	"	"	"	} +9.7°C.
" seventh	"	six		"	"	"	} or+20°C.

The records made in these experiments - in contrast to the experiments formerly described, in which the development of the growing point was traced - had to be confined for lack of time to the change in the habit of the plant. The shooting of the plant is indeed, even without taking longitudinal sections and microscopic study, perceptible to the practised observer in the elongated growth and the development of the nodes. The beginning of earing is also easily recognizable. The first earing took place in Rimpau's Hybrid on the 6th of December in the fifth series (three and a half weeks short-day treatment at +9.7°C.). But the same variety exhibited also in the +20°C. series perceptible shooting under the short-day treatment, whilst no shooting took place in the control. The development of the plants on 9.12 is shown in Figs.5 and 6. The control plants kept under constant long-day conditions at +20°C. exhibit broad leaves (No.1 in Fig.5) without any externally recognizable shooting, the same variety with three and a half weeks short-day treatment and +9.7°C. clearly exhibits shooting, sometimes the last and uppermost leaf is formed (No.2 in Fig.5). The next pot No.3, with four and a half weeks short-day treatment, already exhibits ears. On the extreme right is a variety which is very difficult to bring to earing, Criewen 104, in which in spite of six weeks short-day treatment no shooting is externally perceptible. The condition of the individual plants can be seen for the same date and the same

variety (Rimpau's Hybrid) in Fig.6. The first plant is the control grown under long-day conditions at +20°C.) in the third plant (four weeks short day at +20°C.) and the following shooting can be plainly recognized in the haulm nodes, visible in the photograph. The results of further observations made on 15.1 and 2.2.1938 are seen in Table 8 (p.49). On 15th January shooting is clear also in the other varieties of Series I (three weeks short-day treatment at +20°C.). Thus in Strube's General v. Stocken and Schlanstedt Dickkopf. But the other series with longer short-day treatment have been more hastened in their development as the data concerning the ears already visible show. In every case Rimpau's Hybrid (a variety which shoots readily) is most advanced in its development. If one compared the series with short-day treatment under constant +20°C. with the series having short-day treatment and sixteen and a half hours in +9.7°C., then the last-named series were perceptibly ahead in their development. None of the varieties in the untreated control, on the other hand, gave any recognizable sign of shooting.

pp.49-56.

The last record in these experiments was made on 2.2.1938 (cf. Table 8 second column and Figs.7 to 14).

The illustrations 7 to 14 give a better picture of the

TABLE
Effect of short day upon the
Experiment

No.	Variety.	I (3 weeks short day +20°C.) 15.1.	I (3 weeks short day +20°C.) 2.2.	II (4 weeks short day +20°C.) 15.1.	II (4 weeks short day +20°C.) 2.2.	III (5 weeks short day +20°C.) 15.1.	III (5 weeks short day +20°C.) 2.2.
127	Criewen 104	not shooting	no perceptible shooting	not shooting	not shooting	not shooting	not shooting
135	Salzmünd Standard	not shooting	not shooting	2 ears	10 ears	shooting	3 ears
141	Janetski's frühe Krzg. L. (Early Cross L.)	not shooting	not shooting	1 ear	2 ears; once shooting	shooting	5 ears
186	Svalöf Kronen	not shooting	not shooting	shooting	2 ears	shooting	2 ears
236	Strube's General v. Stock	shooting	1 ear	9 ears	9 ears	1 ear	9 ears
241	Rimpau's Bastard (Hybrid)	shooting	2 ears	10 ears	15 ears, in part dead ripe	13 ears	13 ears, in part dead ripe
278	Dietze's Dickkopf (Squarehead)	shooting	1 ear	2 ears	4 ears	2 ears	7 ears, otherwise shooting
298	Carsten's V.	not shooting	not shooting	some shooting	5 times shooting	shooting	4 ears
381	Ackermann's Bayernkönig	some shooting	some shooting	some shooting	4 times shooting	shooting	1 ear, 4 times shooting

Termination of the above experiment, Jan. 17. The Roman figures indicate
Control on Feb. 2: No.127, ear rudiments 3.0; No.135, ear rudiments
rudiments 6.0; No.236, shooting, ear rudiments 2.0; No.241, ear rudiments
No.381, shooting, ear rudiments over 10.0.

VIII.
shooting of winter wheat varieties.
of 18.8.1937.

IV (6 weeks short day +20°C.)		V (3.5 weeks short day +9.7°C.)		VI (4.5 weeks short day +9.7°C.)		VII (6 weeks short day +9.7°C.)	
15.1.	2.2.	15.1.	2.2.	15.1.	2.2.	15.1.	2.2.
not shooting	not shooting	not shooting	not shooting	not shooting	not shooting (1 plant shooting)	not shooting	not shooting?
shooting	4 ears	3 ears	4 ears	5 ears	7 ears	7 ears	10 ears
2 ears	7 ears	7 ears	10 ears, in part dead ripe	7 ears	8 ears, in part dead ripe	7 ears	7 ears, in part dead ripe
shooting	7 ears	not shooting	some shooting	some shooting	2 ears, shooting	some shooting	1 ear
5 ears	5 ears, in part dead ripe	6 ears	10 ears, in part dead ripe	12 ears	14 ears, in part dead ripe	8 ears	10 ears, in part dead ripe
13 ears	14 ears, in part dead ripe	15 ears	16 ears, in part dead ripe	20 ears	20 ears, in part dead ripe	12 ears	12 ears, in part dead ripe
3 ears	7 ears	7 ears	9 ears, dead ripe	11 ears	14 ears, in part dead ripe	3 ears	4 ears, dead ripe
shooting	2 ears	2 ears	4 ears	4 ears	8 ears, some dead ripe	4 ears	5 ears
some shooting	1 ear twice uppermost leaf	6 ears	15 ears	9 ears	9 ears, of which 6 dead ripe	3 ears	5 ears, dead ripe

the series; VIII = control.
approx. 1.5; No.141, shooting, growing point apical, 1.5; No.186, ear 2.0 to 3.0; No.278, ear rudiments, approx. 2.0; No.298, ear rudiments 2.0;

results of these experiments than Table 8. Rimpau's Hybrid, which may readily be brought to shooting by chilling and short day, in all the series (excepting the long-day control at approximately +20°C.), has come to earing. In this variety therefore short-day treatment both at high temperatures (approximately +20°C.) and at temperatures of approximately +10°C. produced shooting (cf. Fig.7), but the effect of the short-day treatment and the low temperature - as has already been noted - hastened earing more than did short-day treatment with constant high temperatures. (This is equally true of all the varieties tested).

Let us take for purposes of comparison another variety, Ackermann's Bayernkönig, which on the basis of former trials was just as easy to bring to shooting as Rimpau's Hybrid (see Figs.8, 9, 10 and 11). From this illustration it is clear that Ackermann's Bayernkönig reacts quite differently to short-day treatment at high temperatures than does Rimpau's Hybrid. By this treatment (cf. Series II and IV) it is much more difficult to hasten than Rimpau's Hybrid.

A further example of the varietal difference in the action of short-day treatment at high temperatures is Strube's General v. Stocken. Whilst this variety on the basis of its behaviour at low temperatures and short day was more difficult to bring to earing than Ackermann's Bayernkönig, it is easier to hasten its development through

short-day treatment at high temperatures than that of Ackermann's Bayernkönig (cf. Figs.8, 9 and 12).

A further variety which on the basis of our former experiments is to be described as difficult to bring to shooting is Cricwen 104. In this new and differently arranged series of experiments also, it was observed that this variety likewise is difficult to bring to shooting and earing through short-day treatment at high temperatures, in comparison with all the other varieties (cf. Figs.3, 8, 9 and 13). An impression of the behaviour of the variety Carsten's V, also difficult to bring to shooting, is given in Fig.14.

Let us now turn to a brief discussion of the behaviour of the control series, in which the nine winter wheat varieties were exposed to long-day conditions at constant high temperatures from 18.8.1937 onwards. For nearly a half a year they exhibited - to the external view - very rarely a plant in which shooting (not earing) had occurred. But longitudinal sections showed that shooting had taken place in all. The ear rudiments were formed, but for the most part were still very small (between 1.5 and 6.0 cm.; once over 10.0 cm.). All the varieties were therefore very backward in their development as compared with the treated series, nevertheless on the basis of the morphological study it was shown that transition from the vegetative to the reproductive stage had taken place in all in spite of constant high temperature and long-

day conditions. This result, which does not correspond with most of the views represented up to the present, including those of Lysenko, did not surprise me. In various earlier experiments, namely it had been found that with a very long vegetation period winter wheat can come to earing, to flowering and to maturity even under constant warm conditions in the glasshouse and under constant illumination. Thus the variety Criewen 104, very difficult to bring to shooting, had set seed, untreated, on 25.10.1933 in the glasshouse at high temperatures (approximately +20°C.) and with supplementary illumination. It came to flowering and in approximately ten months (on 28.8.1934) had ripened. A similar occurrence took place also in similar experiments in the case of the following winter wheat varieties: Janetski's Early, Mette's Schloss and Probstdorf Kolben.

The action of short day upon the winter wheat varieties, hitherto generally regarded as typical long-day plants, is clearly proved in these experiments. It was shown that the effect of short day even at constant high temperatures, is to promote shooting and to hasten development. The behaviour of the varieties in regard to this kind of treatment may be different in accordance with variety as has previously been shown in determining the so-called "cold requirement". In these earlier experiments no clear information was yet obtained concerning the action of short day

on the winter cereals regarded as long-day plants. In the process worked out by me, which employed low temperatures of approximately +2°C, with eight hours illumination of the germinating seed and of the seedling, a certain effect in the hastening of development was ascribed to the illumination. But at that time one could not yet assume an actual short-day action in this kind of cold treatment. I therefore used - to describe the winter wheat varieties which could be brought to shooting to a different degree - the term "cold requirement" as used by Gassner. Now that by these experiments which I have just described the action of short day alone has been shown to be effective in some varieties I should like to relinquish the use of the expression "cold requirement", because, in my method of inducing shooting, cold and short day work together. Therefore the winter wheat varieties which have been tested by the method described in the introduction are divided into three groups in accordance with their more or less readily induced shooting. These correspond to the groups formerly made in regard to the so-called "cold requirement" (cf. Voss, (55)).

pp.66-72.

The induction of shooting in winter wheat through short-day treatment alone is in my opinion of particular interest, because, even in foreign literature, there is little positive material avail-

able on the subject. Rasumov (35), whose work on the photoperiodic after-effect of short and long day is frequently quoted, only worked with summer cereals. Adams (1), who was one of the first to point out, in 1924, the possible effect of short day upon shooting in winter wheat, worked with one winter wheat and one rye variety, without giving detailed accounts of his experiments, the varieties being sown down from the beginning of March to the end of April in stages, and then transplanted to the open. On account of the quite inadequate explanation of his experimental conditions, however, his findings concerning the effect of short-day can only be considered of hypothetic value. Wanser also (59) discussed the possibility of photoperiodic after-effect on cereals from a purely speculative point of view under the impression of Garner and Allards's discoveries on photoperiodism. Maximov and Pojarkova (24) draw their conclusions indirectly from sowings carried out by them at different seasons. The same applies also, so far as I can judge from the only reference available to me, to the work of E. Lebedinzeva.

So far as I know the German literature contains no perfectly clear proof of the induction of shooting in winter wheat through short day (without low temperature), in the foreign literature there is only the work of O.N. Purvis (34). It is certainly quite possible that, with the abundance of Russian literature in existence, often not available, I may have overlooked something here. O. Purvis

worked in England with a variety of winter rye (Petkus) in detailed investigations in which the development of the growing point received especial attention. By O. Purvis it was shown that short day hastened the development of the flowers in winter rye when the latter germinated at a high temperature (+18°C.). She further showed that temperature and length of day together have an effect upon number of leaves and development of the growing point. The results of this interesting piece of work stimulated me to study the effect of length of day at high germination temperatures in the case of winter wheat also. As my study has shown, conditions are similar in winter wheat. With high temperatures (+20°C.) short day encourages shooting, although to a different degree in the different varieties. But short day and low temperatures (+2°C.) hasten shooting considerably more. Short day and a temperature of approximately +10°C. during the first phase of development take an intermediate position in regard to the degree of acceleration. In all cases however long-day conditions must supplement the various methods of treatment in order to attain the most rapid further development possible. In agreement with O. Purvis' findings it must therefore be concluded that our winter cereal only at its later stages of development, (after the growing point has begun to develop) is to be regarded as a long-day plant, in its first stages of development, on the other hand, it must be

regarded as a short-day plant.

In my own investigations it was further shown that a hastened formation of the growing point and a more rapid incidence of shooting is effected in winter wheat by the factors low temperature and short day. But when the growing time is long enough it is possible in the glasshouse to make winter wheat flower and ripen in approximately eight to ten months at constant warm temperatures also (approximately +20°C.) and under continual illumination. This fact, often observed in our cereal cultures in the glasshouse, while of no practical value for our purposes here, which are the rapid growing of winter wheat for diagnosing varieties and testing varietal resistance, is of considerable theoretical interest.

In this connexion we must discuss the processes of thought developed by Lysenko, alleged to be new, and built up principally on his work on winter wheat, obviously without his knowing the large amount of previous work done by others, and especially by Klebs (18, 19). In this connexion we are not interested in the question of the priority of Lysenko's views, since Ljubimenko (48) and Maximov (26) have already shown, and with right, that the theoretical basis of these views was already formulated a generation ago by Klebs, and that further the effect of cold upon the germinating seed of winter cereals was demonstrated

by Gassner (9) in 1918. It is only desired to ascertain here, on the basis of my own investigations, whether Lysenko's theoretical assumptions can really be regarded as sound. In order to judge the bases of Lysenko's theories reference may be made to the English review "Vernalization and phasic development of plants", which was published in December 1935 by the Imperial Bureau of Plant Genetics. No further discussion of the point first emphasized by Lysenko, namely, that development and growth are not identical, is required. After G. Klebs' clear exposition "On growth and reproduction" (1903) with its distinction between vegetative growth and transition to the formation of the reproductive organs, these distinctions for plant life have been taken as a matter of course for the last thirty years.

Plant development takes place - again according to Lysenko - in different phases, of which, it is asserted, none may be omitted. The first of these phases is determined by the low temperature requisite for, for example, winter cereals, the second by light. If the processes which take place in the germinating seed during the "thermo-phase" are not complete, the cereal plant, according to Lysenko (48, p.3), is not capable of proceeding to the formation of ears.

Let us compare with this again in the first place Klebs, who in his work "On growth and reproduction" just mentioned, quotes

Reinke (1901) on plant development as follows: "Development consists in a sequence or chain of phenomena which we can perhaps best visualize under the image of liberations. The incidence of each phase is liberated by the one which has immediately preceded it ..... no stage ..... can be omitted." This formulation by Reinke is therefore in complete agreement with the views expressed by Lysenko in 1932. Klebs remarks in connexion with this quotation from Reinke, - as will be shown, with complete right - the following: "It is very probably true that the one stage of development creates the necessary conditions for that which follows. But from this it does not follow that it must under all circumstances take place" (Klebs. 18, p.3).

With what justice Klebs has made this important limitation will be shown in the case of winter wheat, the same plant which Lysenko principally used for his experiments. It has previously been shown by me - in agreement with many other workers - that low temperature can encourage shooting even without light. But the same result may be obtained also by the effect of combining two factors, short day and low temperature. This also has been shown by me previously (1934). Now, in agreement with the work of Purvis on rye, it has been shown, for a series of winter wheat varieties that short day alone - <u>without</u> low temperature - encourages shooting. Finally it has been found that also under conditions of long day and constant high temperature winter cereals can eventually flower, even

if very slowly, that is to say proceed from the vegetative to the reproductive stage.

All these facts show that Lysenko's theoretical conclusions that no phase may be omitted in which a certain external stimulant must have effect, are not justified. One sentence only from Klebs in support of this: "The different external stimulants all occasion the arising of this internal decisive alteration" (18, p.57). Cold is by no means effective, as Lysenko maintains, for example only in the first stage of development. As Gassner (9) has already shown and as my own investigations in 1934 confirmed, cold can induce shooting just as well in the case of the already tillered plant. Thus shooting and earing were produced within three months after the conclusion of the cold treatment in plants which had been sown down in late spring, and received when already tillered seven weeks cold treatment, namely, in the following varieties: Probstdorf Kolben, Janetski's Early Hybrid "L", Breustedt's Werla and Mahndorf Zieghardt. The varieties in question were at the end of the cold treatment planted out in the experiment field on 16.7.1934, and finished earing as early as September and October of the same year.

In this connexion the view formerly expressed by Gassner and subsequently represented by Lysenko and others may be briefly discussed, that between the duration of the treatment necessary to

induce shooting and winter hardiness there is a positive relation, or, according to K.O. Müller, a "close correlation". On the basis of the numerous varieties tested here no clear relation of this kind can be found. As has been shown above, the correctness of this formulation also by Lysenko and others must therefore be doubted.

We see therefore that the correctness of the most important points of Lysenko's views must be doubted on the basis of the results which we have here obtained. This must be particularly emphasized, because in the greater number of "vernalization" experiments the theoretical points of view have received very little consideration. It has already been shown that a gradual "sobering" of opinion is taking place in regard to the practical value of the process, and not only in Germany. In the Russian literature, so far as I know, grounded refutation of Lysenko's theoretical conclusions is seldom to be found (cf. Ljubimenko and work from the Maximov school). But for this reason brief reference must be made to those more theoretical conclusions and their incorrectness in the form given by Lysenko made clear. This rejection of Lysenko's theories by no means involves a rejection of this direction of research. On the contrary detailed research on "the arbitrary alteration of development in plants" (Klebs) is not only of theoretical but also of practical value. "We are still, in the case of the phanerogams, far from obtaining a mastery of the organism; but there is every

prospect of obtaining success in the case of them also" (Klebs, 18, 1903, p.59).

We will now finally go into the question, important both practically and theoretically, of whether the separation of winter and summer wheat is free from objection. Lysenko is of the opinion (48, p.12) that the present division into these two main groups is "quite rough and entirely empirical". Apparently he comes to this view under the impression that the varieties can, in accordance with different external conditions, show themselves to be sometimes "winter" forms and sometimes "summer" forms. In other words, he touches upon the problem worked out in detail by Gassner (1918), whether internal periodicity is inherited (according to Pfeffer) or whether the manner of reaction as such is inherited, this manner of reaction being able to express itself in different ways in accordance with the external constellations, themselves subject to great variation under natural conditions. According to the well known experiments of Baur (3) on inheritance of flower colour, which may be differently manifested (white or red) in accordance with external conditions, it is absolutely clear that only the manner of reaction is inherited. If, now, it is observed that the same winter wheat variety shows itself in one region to be a winter form, and in another - perhaps very different in regard to climate - as a summer form, one cannot therefore conclude from it that the whole

division into winter and summer forms is impossible. For certain, not even confined regions, experience shows the division into winter and summer forms made by the practical plant grower to be generally correct. My own study of several hundred German winter wheat varieties and new bred strains has shown that the percentage of those varieties which, even after exact physiological analyses of the "manner of reaction" do not behave like winter wheat, was very insignificant. It lay somewhere between 1 and 2 per cent. The "error" of the usual countryman's grouping - which had been made on the basis of the conditions prevalent throughout the whole of Germany - was therefore relatively very low. It could of course be very much higher if the same varieties were transferred to a greatly different climate, as for example, that of southern countries.

For exact physiological investigations one must of course know what is meant by the terms "winter wheat" and "summer wheat". In my opinion an exact formulation of these terms may be obtained by taking as a prerequisite certain definite external conditions. One may, for example, describe "winter wheat" and "summer wheat" as follows: "wheat varieties, which under a constant high temperature (approximately +20°C.), constant illumination (by natural or artificial light, as far as possible not $<$1500 luxes), and otherwise favourable conditions in a hothouse do not exhibit the beginning of shooting within four to six weeks, are described as winter wheats.

All varieties, however, which within the above-named period exhibit the beginning of shooting are described as summer wheats." By "shooting" is understood the beginning of the differentiation of nodes and internodes, which can be established by longitudinal sections and observation of the plant under the binocular with a magnification of 30. The further differentiation of the growing point to the rudimentary ear has set in at the same time.

Summary.

1. In confirmation of findings in 1934 the expression "acceleration of development" [in German one word] is used in place of the half-Russian expression "jarovisation". In processes the object of which is the acceleration or slowing down of development, the expression "alteration of development" may be used. By the choice of these expressions it is attempted to avoid ambiguity. For the purpose of further elucidation there may be added to these expressions: "according to T.D. Lysenko" or "through short day and cold" etc.

2. The German winter wheat varieties are divided in accordance with the degree of ease with which shooting may be induced (judged according to the development of the growing point as well as the differentiation of nodes and internodes), and form three groups in which the induction of shooting is easy, moderately

difficult, and difficult respectively.

3. By testing for several years the induction of shooting in more than 100 winter wheat varieties (1933-37) by the process formerly described by me (cold combined with short day) it was shown that it is a question here of a heritable physiological varietal character, which is independent of the origin of the seed.

4. The consistent behaviour of the varieties under the induction of shooting was exhibited both in the hothouse under constant illumination and in field trials (1934 and 1935).

5. By chilling germinating seeds of summer wheat varieties no acceleration of development, or only a slight acceleration was obtained in a field experiment (1937).

6. By altering the time of sowing (autumn sowing) of early and late summer wheat varieties (1930 to 1937), no "reversal" could be obtained in their rhythm of development.

7. The effect of short day under conditions of constant high temperature (approximately +20°C.) in inducing shooting has been proved in German winter wheat varieties.

8. The varieties tested here can be brought to shooting in different varietal manner by the action of short day.

9. The manner in which a winter wheat variety reacts to treatment may differ in the same variety (a) under combined cold and short-day treatment, and (b) under short-day treatment alone

(at high temperatures).

10. With a very long time of vegetation winter wheat may also be brought to flowering under constant illumination and high temperatures.

11. No specific effect in inducing flowering was obtained through a weekly dose of α-follicle hormone (1000-3000 M.E.) applied to winter and summer wheat varieties in pot trials (vegetation trials 1936 and 1937).

12. The winter wheat plant can pass from the vegetative to the reproductive phase of development as a result of different external factors acting alone or in combination at different stages of development. To them belong in particular low temperatures and short day, provided that their adequately long action is again followed by long-day conditions.

13. Winter wheat - as O. Purvis has shown in the case of winter rye - is to be regarded at certain early stages of development as a short-day plant.

14. German winter and summer wheat varieties can be clearly distinguished from one another when the conditions of experimentation are strictly limited as described in this article. A corresponding formulation of the terms "winter wheat" and "summer wheat" is proposed. Therewith the possibility of employing a uniform criterion in determining the summer or winter character of a variety, of use for all

countries, is shown.

15. No clear correlation can be established in the winter wheat varieties tested here between the manner in which shooting may be induced and winter hardiness.

16. A number of important theoretic assumptions on plant development formulated by T.D. Lysenko have been shown to be incorrect in the winter wheat plants tested here, the same plant used in the main by Lysenko in his investigations.

LITERATURE.

1. ADAMS, J. Does light determine the date of heading out in winter wheat and winter rye? Amer. J. Bot. 11. 535-9. 1924.
2. APPEL, O., and GASSNER, G. [The injurious effect of too high germination temperatures upon the later development of cereals.] Mitt. biol. Reichsanst. No.4. 5-6. 1907.
3. BAUR, E. [Introduction to experimental genetics.] Berlin, 1922.
4. BOEKHOLT, K. [Investigations on the development rhythm and the construction of yield in summer wheat varieties when grown in different climatic regions of Europe, and the influence of origin upon the nature of the grain, upon yield and the structure of yield.] Landw. Jb. 78. 123-46. 1933.
5. EULER, H. v., and ZONDEK, B. [Folliculin and plants. Experiments with hyacinths and with yeast.] Biochem. Z. 271. 64-73. 1934.
6. FEEKES, W. Vernalization and modern cultivation of crops (with special reference to wheats). Chron. Bot. 4. 24-7. 1938.
7. FEISTRITZER, W. [The vernalization of agricultural crop plants.] Züchter. 6. 153-5. 1934.
8. FORSTER, H.C., TINCKER, M.A.H., VASEY, A.J., and WADHAM, S.M. Experiments in England, Wales and Australia on the effect of length of day on various cultivated varieties of wheat. Ann. appl. Biol. 19. 378-412. 1932.

9. GASSNER, G. [Contributions to the physiological characteristics of summer and winter annuals, with special reference to the cereals.] Z. Bot. 10. 417-80. 1918.
10. GREGORY, F.G. Photoperiodicity in cereals. Proc. 6th Int. Bot. Congr. 2. 18-20. 1935.
11. HARDER, R., and STÖRMER, J. [On the influence of the follicle hormone on the flowering of plants.] Jb. wiss. Bot. 80. 1-19. 1934.
12. _____ [On the acceleration of development in short day by the after-effects of cold.] Landw. Jb. 83. 401-15. 1936.
13. _____ and DENFFER, D. v. [On the combined action of vernalization and photoperiodism.] Züchter. 9. 17-23. 1937.
14. HEUSER, W., and ZEINER, W. [The effect of vernalization through temperature and length of day upon the rhythm of development and the structure of yield in different summer wheat varieties, and its importance for their reaction to the time of sowing.] Pflanzenbau. 13. 106-19. 1936.
15. HURWITZ, S. [Effect of temperature and time of sowing upon the development of winter cereals.] Arch. PflBau. 9. 427-69. 1932.
16. Vernalization-Bull. No.1. 62. Jan. 1932.
17. KRASSNOSSELSKY, and MAXIMOV, T.A. [On distinguishing winter and summer cereal seed in the laboratory.] Wiss. Arch. Landw. 7. 562-8. 1931.
18. KLEBS, G. [Spontaneous change in the development of plants. A contribution to the physiology of development.] 1903. pp.166.
19. _____ [Reproduction of plants. Physiology.] Handwörterbuch der Naturwissenschaften. 4. 276-97. 1913.
20. KNODEL, H. [Can Klebs' view on the dependence of flower formation upon the chemical composition of the plant be maintained?] Z. Bot. 29. 449-501. 1936.
21. LEBEDINZEVA, E. [The significance of the day length for the earing of winter cereals.] Trudy Prikl. Bot. Ser.3. No.3. 141-54. 1933. Imperial Bureau of Plant Genetics: Herbage Plants, Bull. No.17. 28. 1935.
22. LEMMERMANN, O., and BEHRENS, W.U. [The effect of growth substances (hormones) on plant growth.] Z. PflErnähr. Düng. 13, 9-12. 1934.
23. LOEWE, S., RAUDENBUSCH, W., VOSS, H.E., and HEURN, Jh. W.C. van. [Determination of the existence of the sexual hormone in butterflies.] Biochem. Z. 244. 347-56. 1932.

24. MAXIMOV, N.A., and POJARKOVA, A.J. [The physiological nature of the differences between summer and winter cereals.] Jb. Bot. 64. 702-30. 1925.
25. _____ [Experimental alterations in the length of the vegetation period in plants.] Biol. Zbl. 49. 513-43. 1929.
26. _____ The theoretical significance of vernalization. Imperial Bureau of Plant Genetics: Herbage Plants, Bull. No. 16. 12. 1934.
27. MEICHERS, G. [The action of genes, low temperatures and flowering scions upon flowering maturity in Hyoscyamus niger L.] Biol. Zbl. 57. 568-614. 1937.
28. MÜLLER, K.O. [Contribution to the knowledge of the summer-winter type in Triticum vulgare. Preliminary communication.] Angew. Bot. 18. 231-9. 1936.
29. NEHRING, K. [On the existence of substances of an oestrogenous nature (follicle hormone) in farmyard manure and liquid manure and their effect upon plant growth.] Ber. Tag. Forschungsdienst Würzburg. Part 2. 110-23. 1935.
30. NOGUCHI, J. [Studies on the development of the inflorescences and flowers in cereals.] J. Coll. Agric. (Tokyo). 10. 248-302. 1929.
31. OETTINGEN, H. v. [The nature and significance of vernalization.] Dtsch. landw. Presse. 60. 581. 1933.
32. ORTH, H. [The effect of the follicle hormone on the development of the plant.] Z. Bot. 27. 565-607. 1934.
33. PESOLA, V.A. [On the winter hardiness of the winter wheat varieties Staatl. Landw. Vers.-Veröff. No.65. Helsinki, 1934.
34. PURVIS, O.N. An analysis of the influence of temperature during germination on the subsequent development of certain winter cereals and its relation to the effect of length of day. Ann. Bot. 48. 919-55. 1934.
35. RASUMOV, V.J. [The photoperiodic after-effect in relation to the effect of different times of sowing upon plants.] Planta. 10. 345-73. 1930.
36. ROSENBAUM, H. [Research on the acceleration of development in soybeans.] Angew. Bot. 19. 442-91. 1937.
37. RUDORF, W. [Vernalization in relation to plant breeding.] Züchter. 7. 193-9. 1935.
38. SACHS, J. [Substance and form of the plant organs.] Arb. Bot. Inst. Würzburg. 2. 452-88. 1882.
39. SAPEHIN, A.A. [The importance for breeding purposes of Lysenko's method of shortening the vegetation period.] Züchter. 4. 147-51. 1932.

40. SCHEIBE, A. [The germination of the oat in its dependence on the physiological constitution of the seed.] Pflanzenbau. 8. 579-649. 1932.
41. SCHARRER, K., and SCHROPP, W. [The effect of follicle hormone crystals on the growth of some cultivated plants.] Biochem. Z. 281. 314-28. 1935.
42. SCHOELLER, W., and GOEBEL, H. [The effect of the follicle hormone on plants.] Biochem. Z. 240. 1-11. 1931.
43. _____ [The effect of the follicle hormone on plants, II.] Biochem. Z. 251. 223-8. 1932.
44. _____ [The effect of the follicle hormone on plants, III.] Biochem. Z. 272. 215-21. 1934.
45. _____ [The effect of oestrogenous substances on plants, IV.] Biochem. Z. 278. 298-311. 1935.
46. SEELHORST, C. v. [The effect of intermittent lowering of temperature upon the development of winter crops which are sown in the spring.] J. Landw. 46. 50-1. 1898.
47. TAMM, E., and PREISSLER, R. [Contributions to the vernalization and photoperiodic influencing of winter cereals, together with some preliminary experiments on flax.] Z. Züchtg. A. 22. 147-80. 1937.
48. Vernalization and phasic development of plants. Imperial Bureau of Plant Genetics: Herbage Plants, Bull. No.17. 1935.
49. VIRTANEN, A.I., HAUSEN, S.v., and SAASTAMOINEN, S. [The effect of the follicle hormone on the flowering of the plant.] Biochem. Z. 272. 32-5. 1934.
50. VOGT, R. [The behaviour of winter and summer cereals when grown in the summer, in the autumn and in spring, with special reference to shooting.] Diss. München, 1926.
51. VOSS, J. [Morphology and grouping of the German winter wheat varieties. (Description of the science of varieties in Triticum vulgare.)] Mitt. biol. Reichsanst. No.45. 1-112. 1933.
52. _____ [Transformation of winter wheats into summer wheats?] Dtsch. landw. Presse. 61. No.1. 1934.
53. _____ [Distinguishing between summer and winter wheats.] Züchter. 6. 19-24. 1934.
54. _____ [Investigations on the acceleration of development and growing of winter wheats in the hothouse.] Pflanzenbau. 10. 321-31. 1934.
55. _____ [Distinguishing wheat varieties by the grain and in the laboratory trial.] Mitt. biol. Reichsanst. No.51. 1935.
56. _____ [The influence of different kinds of light and radiation upon the development of agricultural crop plants.] Angew. Bot. 18. 43-75. 1936.

57. VOSS, J. [Experimental induction of shooting and testing of shooting capacity in beet varieties. (Beta vulgaris L.)] Angew. Bot. 18. 370-407. 1936.
58. _____ [On the technique of testing wheat varieties for their resistance to Tilletia tritici.] Pflanzenbau. 14. 113-53. 1937.
59. WANSER, H.M. Photoperiodism of wheat: a determining factor in acclimatization. Science. 56. 313-5. 1922.
60. WHYTE, R.O., and HUDSON, P.S. Vernalization or Lysenko's method for the pre-treatment of seed. Imperial Bureau of Plant Genetics: Herbage Plants, Bull. No.9. 1933.

BITTERA, N. v., and GRUBER, F. v. Wachstumsuntersuchungen einiger Grasarten mit und ohne Bewässerung. [A study of growth in certain grass species, with and without watering.] Pflanzenbau. 14. 153-6. 1937. [Agric. Coll., Magyar-Ovar, Hungary.]

Translated from German. (G.M.R.)

When one reads descriptions of the individual grass species in the literature, one always finds information as to whether they grow slowly or rapidly. Data are generally given in general terms only, but not in figures. Growth rhythm is probably dependent upon external circumstances, but nevertheless it may not be superfluous to illuminate this question by means of our own investigations.

On the experiment field of the Agricultural College at Magyaróvár, Hungary, we laid down some experiments in 1935 which were designed to study the effect of watering upon the growth of certain grass species.

The soil is medium heavy loam containing lime (21 per cent $CaCO_3$) with sandy gravel in the subsoil (80 to 100 cm.).

The climate is dry. Average annual precipitation, 560 mm. Long periods of drought are frequent in the spring and summer. There was particularly low rainfall (340 mm.) in the years 1932 and 1933. In 1934 precipitation was 436 mm. In the year of the experiment,

1935, the distribution also was unfavourable: I. 36.8, II. 63.4, III. 29.9, IV. 51.1, V. 61.0, VI. 12.0 mm.

The experiment plants were: Arrhenatherum elatius, Alopecurus pratensis, Poa pratensis, Agropyron cristatum, Festuca pratensis, Dactylis glomerata, Baldingera arundinacea, Bromus inermis, Festuca rubra var. genuina, Lolium perenne, Festuca ovina, Festuca rubra and Agrostis stolonifera.

At the beginning of the experiment, May 1935, they were fourteen months old. Of each species 25 plants, in triplicate, were fastened loosely to a centimetre rule. The growth in height was recorded twice daily, at 7 a.m. and 6 p.m., for the same shoot of each plant.

Some of the plants received natural rainfall only, and some were further watered every other day with soft water that had been left standing, the amount corresponding to 2 mm. rain.

Growth rhythm in the grasses is dependent on many factors. If these are all available in optimal measure, the plant develops luxuriantly. The most important of these factors are soil and climate.

In soil the composition (light or binding), activity and vigour, manurial condition, reaction, tilth, and water relations (water table in this case 250 cm.) are of decisive importance.

Of the climatic conditions temperature, precipitation,

humidity, and wind play a great part, in addition to sunshine.

Every plant requires at every stage of development a certain amount of warmth, below the minimum and above the maximum of which there is no growth. The optimum for the development of height in grasses lies generally between 20 and 30°C.

In the month of May of the experiment year the temperature varied from +0.3 to 23.8°C. The grass grew best at a temperature of 18 to 23°C.

Arrhenatherum elatius grew for instance at 22°C. 4 cm. daily, on the other hand it hardly grew at all at 7 to 8°C. No measurable difference in height could be determined in Baldingera arundinacea at a temperature of 12°C. Vigorous growth set in at 23°C. Similar behaviour was observed in Agrostis stolonifera and Bromus inermis.

Optimal growth temperatures were found to be as follows:

Festuca ovina and Poa pratensis	7 to 21°C.
Festuca rubra	11 to 23°C.
Agropyron cristatum and Lolium perenne ...	6 to 21°C.
Festuca pratensis	9 to 23°C.
Alopecurus pratensis	9 to 20°C.
Dactylis glomerata	8 to 22°C.

Grasses which develop early in the spring require less warmth.

It should be noted that it is only possible to set superficial limits to growth in this way. The highest temperature was recorded in May (in the shade), 23.8°C. The behaviour of the grasses

humidity, and wind play a great part, in addition to sunshine.

Every plant requires at every stage of development a certain amount of warmth, below the minimum and above the maximum of which there is no growth. The optimum for the development of height in grasses lies generally between 20 and 30°C.

In the month of May of the experiment year the temperature varied from +0.3 to 23.8°C. The grass grew best at a temperature of 18 to 23°C.

Arrhenatherum elatius grew for instance at 22°C. 4 cm. daily, on the other hand it hardly grew at all at 7 to 8°C. No measurable difference in height could be determined in Baldingera arundinacea at a temperature of 12°C. Vigorous growth set in at 23°C. Similar behaviour was observed in Agrostis stolonifera and Bromus inermis.

Optimal growth temperatures were found to be as follows:

Festuca ovina and Poa pratensis	7 to 21°C.
Festuca rubra	11 to 23°C.
Agropyron cristatum and Lolium perenne ...	6 to 21°C.
Festuca pratensis	9 to 23°C.
Alopecurus pratensis	9 to 20°C.
Dactylis glomerata	8 to 22°C.

Grasses which develop early in the spring require less warmth.

It should be noted that it is only possible to set superficial limits to growth in this way. The highest temperature was recorded in May (in the shade), 23.8°C. The behaviour of the grasses

at higher temperatures could not be determined.

The duration and energy of sunshine also play an important part.

	Growth in cm.	
	Warm, sunny days	Cool, overcast days
Baldingera arundinacea	4.2	2.3
Arrhenatherum elatius	4.0	2.2
Dactylis glomerata	3.9	2.1
Bromus inermis	3.0	1.0
Alopecurus pratensis	2.2	1.8
Festuca pratensis	2.0	1.2
Agropyron cristatum	2.0	0.4
Lolium perenne	1.5	0.5
Festuca rubra var. genuina .	1.4	0.3
Festuca rubra	1.0	0.2
Poa pratensis	0.6	0.2
Agrostis stolonifera	0.4	0.0
Festuca ovina	0.3	0.0

As a rule all the grasses grow more vigorously on warm, sunny days. The difference between the days' growth on sunny and overcast days respectively was considerable in the case of Bromus, Arrhenatherum elatius, Dactylis glomerata and Agropyron. Festuca ovina, Agrostis stolonifera and Poa pratensis seem to be less susceptible to overcast weather.

It is generally known that the growth of plants is dependent upon precipitation to a great degree. It is also clear that the same quantity of rain can have quite different effects upon soils of different composition, and that the temperature has a great

influence upon the effect of the same amounts of precipitation. In order to obtain more exact data in figures, some of the experimental plants received a moderate amount of watering (as far as was economically expedient).

Arrhenatherum elatius, Alopecurus pratensis, Festuca pratensis, Poa pratensis, Dactylis glomerata and Phalaris arundinacea responded well to watering. On the other hand in our experiment watering had no effect upon the growth and yield of Agrostis.

	Height of plants cm.		Yield of hay dz. per ha.		Difference in favour of watering	
	Unwatered	Watered	Unwatered	Watered	Height cm.	Yield of hay dz. per ha.
Arrhenatherum elatius ...	34.0	65	28.9	52.6	29	23.7
Alopecurus pratensis	37.0	55	21.2	32.4	18	11.2
Poa pratensis	21.0	38	15.3	23.8	17	8.5
Agropyron cristatum	29.0	42	15.3	22.2	13	6.9
Festuca pratensis	40.0	52	29.2	44.2	12	15.0
Dactylis glomerata	47.0	58	32.8	47.6	11	14.8
Phalaris arundinacea	35.0	45	17.0	40.8	10	23.8
Bromus inermis	52.0	61	27.0	32.3	9	5.3
Festuca rubra var. gen...	26.0	32	17.7	20.4	6	2.7
Lolium perenne	24.0	29	18.7	20.7	5	2.0
Festuca ovina	31.5	35	13.6	15.3	4	1.7
Festuca rubra	34.0	38	19.7	22.1	4	2.4
Agrostis stolonifera	20.0	20	12.3	12.3	0	0.0

The above table shows growth vigour in May 1935.

Watering, done at the right time before cutting, generally had a good effect.

The rapidly growing grasses have so high water requirements that they can seldom be covered by natural precipitation. The temperature is generally high just before hay harvesting in this country. This circumstance increases not only the activity of the plants, but also evaporation. To this must be added the winds of spring, which still further dry the plants. If in addition to all this the soil also is permeable, then the water requirements necessary for the full development of the grasses cannot be covered by natural rainfall. Only in this manner is it possible to explain the fact that the watering of grass was found to be useful although the amount of precipitation was favourable, namely, 66.0 mm. for 12 days, May 1935.

Watering is an effective means of increasing the quantity and quality of the hay harvest. Luxuriant and vigorously growing grass has more delicate tissues, is more nutritious and more digestible. Naturally attention must be paid to suitable manurial treatment.

In order to ensure as good results as possible from watering, the seeds mixtures destined for sowing down watered areas should be so composed that the grasses which respond to watering form the larger proportion.

ZEHFNINER, M. Der Einfluss steigender Kaligaben auf Ertrag und Zusammensetzung eines Kleegrasgemenges. [The effect of ascending doses of potassium upon the yield and composition of a clover-grass mixture.] Berlin, 1938. pp.82. pl.

Translation of summary from German. (C.M.R.)

The effect of graded doses of potassium upon yield, botanical and chemical composition of a clover-grass mixture was tested in pot trials, and together therewith the influence of the changing anions - Cl or SO_4 - and the effect of applying sulphate of magnesia also:

1. The experiment was laid down in March, 1935, at the Agricultural Experiment Station, Lichterfelde, Berlin, in a sand-peat mixture, wherein, in addition to the basal manuring five graded doses of potassium in fourfold replication were employed. The whole experiment was carried out once with $MgSO_4$, once without. After the first cut, in the middle of July a further application of the first N, P, K and Mg doses was made at half the rate.

2. The clover-grass was composed of Trifolium hybridum, Lolium italicum and Phleum pratense at the rate of 20 per cent for the Trifolium and 40 per cent each for the two grasses. The seed was inoculated with Nitragin.

3. In the series "KCl without $MgSO_4$" disturbances of development were soon apparent, and led finally to the dying back of the plants. For this reason no botanical and chemical analyses were made.

4. In the case of the second and third lowest doses of potassium the hybrid clover generally exhibited white spot as a symptom of potassium deficiency, in addition brown leaf edges, and in the case of the grass a dying back of the leaf tips.

5. The series K_2SO_4 + $MgSO_4$ was the most vigorous and healthy, and the clover flowered best in this series. As also KCl + $MgSO_4$ exhibited greater flowering vigour than the two series without $MgSO_4$ there seems to be a connexion here with the supply of magnesia.

6. An increase in the amount of potassium applied was expressed in a correspondingly improved development of the clover.

7. When there were lower applications of K there was a greater incidence of mildew and aphid infection.

8. The first harvest was taken at the beginning of July, the second, which was notably less rich in clover, in the middle of September. No aftermath worth mentioning grew in the autumn of 1935. The attempt to continue growth through the winter was unsuccessful.

9. We immediately made botanical analysis of the crop

from each pot and determined the dry weight for each plant species.

10. The chemical laboratory of the Station analysed the crops for ash, potassium, calcium, magnesia and sulphate content. Determination of nitrogen was carried out by the author himself by the Kjeldahl method.

11. In studying the result we tested first of all on the basis of recent literature the growth and individual requirements of the three plant species, and judged in accordance therewith the behaviour of the mixture in relation to supplies of water, light, warmth, soil and supply of nutrients. The water at times of the heaviest requirements was not always quite sufficient, the illumination of the inner part of the dense stands was also not quite sufficient. The "sterile" sand-peat mixture proved satisfactory even for Trifolium hybridum after inoculation with Nitragin. The supply of nutrients was sufficient (apart from the low doses of K and sometimes the magnesia), as was proved by the records of growth and the chemical analyses.

12. The distribution of the total harvest over the two cuts was considerably influenced by the relatively late time at which the first cut was taken. It was desired to observe the effect of the various applications by the time when the clover was in full flower, so that often the development was further advanced than is desirable for the production of good quality green fodder

or hay. For this reason the composition of the first cut and the yields of the second suffered. On an average of the three series of experiments which could be used, of the one-cut hybrid clover only 18 per cent of the whole dry weight belonged to the second growth, of Lolium multiflorum on the other hand 60 per cent and of Phleum pratense 42 per cent.

13. The development of the mixture in the pot trials we compared with the corresponding results obtained from an experiment carried out at the same time in the open. The two cuts were taken here at exactly the same time as in the case of the pot trials. In the open the second growth was somewhat more abundant than the first. The botanical analysis showed a greater uniformity in all the sixteen plots. The percentage area covered by clover and grass (almost entirely Lolium) was approximately equal, but the percentage weight was in the case of the hybrid clover as much as three-quarters of the crop. Clover growth was therefore much more encouraged in the open than in the pots.

14. In the pot trial the clover gave approximately 39 per cent of the first cut, and only 29 per cent of the dry weight for the two cuts.

15. Hereupon we examined the influence of the increasing doses of potassium upon the amount and composition of the harvest. An increased production of approximately 7 grm. dry weight was

obtained from 1 grm. potassium. As is seen in the diagram of Fig.1 (orig. publ.), the increase in the application of potassium resulted in a fairly uniform increase in the harvest; the increase from 2 to 3 grm. K_2O diminished in effect, results which are in harmony with experiments which have been made elsewhere. The proportion of clover was more than doubled by increasing the dose of potassium (Fig.2). Most effective was the increase of the preliminary manuring from 1 to 2 grm. K_2O.

16. The potassium content of the clover was only partly increased through increasing the application of K. Comparison of the analyses with the literature showed that the potassium applied in the lower doses was insufficient. Ehrenberg's potassium-calcium antagonism was to a certain degree confirmed. In the grass the content of potassium and calcium altered just as in the clover. The protein harvest was almost doubled by increasing the dose of potassium (Fig.3).

17. Of the potassium deficiency symptoms observed white spot has already been recorded for other Trifolium species, but not so far as we know for Trifolium hybridum. The photographs give a picture of these symptoms.

18. In respect to the effect of sulphate of magnesia we first of all made a study of previous work, in part by the author himself, and also referred to some more recent experimental work.

19. In our pot trials the $MgSO_4$ series flowered with considerably more vigour than the minus $MgSO_4$ series.

20. The dry weight, especially that of the clover, was increased by adding sulphate of magnesia to the other fertilizer.

21. As it is not yet possible to judge the magnesia content of soil by chemical or biological means, it is recommended to employ, especially on the lighter soils in the humid climate of Germany, potassium fertilizers containing magnesia.

22. The percentage area covered by clover, in addition to the yield of clover, was increased by the use of $MgSO_4$, even in conjunction with the heaviest K_2SO_4 doses, so that it cannot only be a question of the action of sulphate.

23. The magnesia content of the harvest was increased by the addition of Mg to the fertilizers; in the case of the hybrid clover the increased yield, however, was so great when there was a better supply of potassium that its percentage of Mg remained low in comparison with data obtained in the open.

24. No clear determination of the various magnesia deficiency symptoms described in the literature could be made in our experiments.

25. Even if the magnesia content of the soil gives rise to no deficiency symptoms, sulphate of magnesia is able to produce an improvement in the quantity and quality of the fodder.

26. The sulphate and calcium content was irregularly changed by adding $MgSO_4$ to the increasing doses of potassium sulphate, the potassium content was lowered.

27. The yield of protein was increased when sulphate of magnesia was added to the fertilizers. According to this the employment of this magnesia compound is to be recommended from the viewpoint of protein production also.

28. Finally the influence of the anions attached to potassium - Cl or SO_4 - were studied. In practice it is a question of what effect is obtained by the substitution of sulphate of potassium for the chloride of potassium almost always used in forage crop production up to the present. For this reason a study was first made of the German and foreign literature concerning the manner in which clover responds to sulphates, which to a large extent may be responsible for the practice of manuring with gypsum.

29. The greater yield obtained in our experiments by substituting K_2SO_4 (together with $MgSO_4$) for KCl is certainly inferior to the increased yield obtained by $MgSO_4$; the botanical composition of the clover-grass also was less strongly influenced, so that from this point of view also the potassium fertilizers containing Mg should be given the preference.

30. The sulphate content of the crop was, as is comprehensible, more increased by the heavier doses of K_2SO_4 than merely by

the additional use of $MgSO_4$.

31. The absorption of the cations K, Ca and Mg was inhibited in the sulphate series in comparison with the chloride series.

32. The content of crude protein was irregularly influenced, the yield of crude protein, however, considerably increased.

33. By means of comparative information from the literature it was shown why the conditions for development are less favourable for legumes in pots than in the field and how therefore the action of the fertilizers, both in the ascending doses of K and also in the case of $MgSO_4$ or SO_4, is detrimentally affected.

34. The symptoms of potash deficiency and also the action of the various fertilizers in increasing the yield of the mixture are illustrated by photographs.

WALLEBROEK, J. C. J. Alkaloiden en stikstof-stofwisseling bij de kieming van Lupinus luteus. [Alkaloids and nitrogen metabolism in the germination of Lupinus luteus.] Ned. kruidk. Arch. 47. 104. 1937. [Address delivered to the Botanical Association of the Netherlands.]

Translated from Dutch. (G.M.R.)

The speaker has not been able to determine any change in the total alkaloid content of Lupinus germinated in the dark. When the lower parts of the seedling are analysed, the alkaloid decrease in the cotyledons appears to keep step with the increase in plumule and radicle. The technique did not allow it to be determined whether this was a case of translocation or whether there is breaking down on the one hand and synthesis on the other. Some arguments in favour of breaking down and synthesis may be produced. In germination in the light the quantity of alkaloid increased perceptibly in fourteen days. The speaker found that the formation of alkaloids in germination takes place in the plumule and rootlet, a result which is not entirely in agreement with what might be expected from Trier's view concerning alkaloid formation. In order to make this clear, the metabolism of nitrogen in germination was briefly outlined. Proteolysis, removal of the amino group from the amino acids, asparagine synthesis,

synthesis of the amino acids and the building up of protein were discussed. The possibility was mentioned of a connexion existing between synthesis of the amino acids and alkaloid formation. It is possible that the alkaloids are products of a subsidiary reaction in the synthesis of the amino acids. Hereby the somewhat remarkable correspondence between the structure of the two groups of compounds would be explicable. From the behaviour of the alkaloids of Lupinus luteus in germination it does not by any means follow that they are the rigid, immovable and unassailable refuse products of metabolism to which Tschirch's description of "compounds washed up on the shore" is applicable.

RIET, J., ECHENIQUE, L., and SANZ, D. L. El problema de la intoxicación de los bovinos por el Sudan grass. (Segunda comunicación) Intervention de la fisiología de los reservorios gástricos en relación con la secreción salivar. [The poisoning of cattle by Andropogon sorghum var. Sudanensis. (Second communication). Intervention of the physiology of the stomachs, with reference to the secretion of saliva.] Arch. Soc. Biol. Montevideo. 8. 25-45. 1937. [Inst. Bact., Fac. Vet., Montevideo.]

Translated from Spanish. (G.M.R.)

The first communication dealt with the influence of acidity and alkalinity respectively upon cyanogenesis [see Herb. Abstr. 6. 341. 1936].

Summary.

In the present communication the authors describe tests of liquid obtained from the stomachs of cattle which had just been killed, with a view to discovering why in some cases cattle may consume large quantities of cyanogenetic material without experiencing any ill effects, and in others death results from the consumption of Sudan grass which, on analysis, does not exhibit an unusually high content of HCN. They consider that there should be taken into account,

rather than the intensity of the Guignard reaction, the presence or otherwise of factors in the animal organism which can liberate HCN.

The alkalinity of the rumen, normally oscillating in the vicinity of 8.9, entirely inhibits the liberation of HCN, even in Sudan grass in its young and most toxic stage, and thus renders it innocuous to the animal. The saliva of cattle exercises a clearly inhibitive action upon cyanogenesis in Sudan grass. The acidity of the content of the abomasum should not inhibit the liberation of HCN. In our experiments the liquid from the abomasum gave more intense reactions than the control liquid made from water only, and comparable with those obtained from hydrochloric acid in concentrations equivalent to the acidity of the abomasum.

Both the glucoside and the ferment are separated rapidly from the tissues of Sudan grass when the macerated plant comes into contact with water, so that the filtration, after this contact, gives positive reactions on Guignard paper.

Samples of Sudan grass with a high content of HCN lose their cyanogenetic properties after exposure to an alkaline medium, and remain negative when a suitable amount of acid has been added. When the time of exposure has been insufficient or when the degree of alkalinity is moderate, part of its hydrocyanic properties may be conserved. With the addition of hydrochloric acid or acetic acid in appropriate quantities, the liberation of HCN may be

rather than the intensity of the Guignard reaction, the presence or otherwise of factors in the animal organism which can liberate HCN.

The alkalinity of the rumen, normally oscillating in the vicinity of 8.9, entirely inhibits the liberation of HCN, even in Sudan grass in its young and most toxic stage, and thus renders it innocuous to the animal. The saliva of cattle exercises a clearly inhibitive action upon cyanogenesis in Sudan grass. The acidity of the content of the abomasum should not inhibit the liberation of HCN. In our experiments the liquid from the abomasum gave more intense reactions than the control liquid made from water only, and comparable with those obtained from hydrochloric acid in concentrations equivalent to the acidity of the abomasum.

Both the glucoside and the ferment are separated rapidly from the tissues of Sudan grass when the macerated plant comes into contact with water, so that the filtration, after this contact, gives positive reactions on Guignard paper.

Samples of Sudan grass with a high content of HCN lose their cyanogenetic properties after exposure to an alkaline medium, and remain negative when a suitable amount of acid has been added. When the time of exposure has been insufficient or when the degree of alkalinity is moderate, part of its hydrocyanic properties may be conserved. With the addition of hydrochloric acid or acetic acid in appropriate quantities, the liberation of HCN may be

obtained in variable quantities.

Under normal conditions cattle are immune to the toxicity of Sudan grass. The development of the glucoside being inhibited, they can consume large quantities of cyanogenetic herbage without inconvenience. The single or cumulative action of various factors may intervene to destroy this organic defence, permitting the development of the glucoside and therewith bringing about the poisoning of the animals. Among these factors we distinguish the diminution of alkalinity in the rumen. A modifying effect upon the content of the rumen may be exercised by alterations in the digestive system, abnormal fermentations, timpanitis, ruminitis, etc. In the same way modifications of the secretion of saliva may intervene, depriving the rumen, when salivation is reduced, of one of its important elements of alkalization.

The consumption of extremely tender and juicy herbage is accompanied by decreased salivation. Milking, especially in the case of very heavy milkers, may render salivation difficult.

The closing of the oesophageal groove may be a factor productive of poisoning when the passage of sufficient quantities of cyanogenetic liquid to the abomasum is possible.